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INFLUENCE OF THE EDGES OF THE TIPS ON THE MOTION OF THE WING WITH VIBRATIONS AT SUPERSONIC SPEED

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Note 1 showed that to determine $\partial\varphi/\partial z$ in the region EDF and $E_1D_1F_1$ /761*
(fig. 1) with wing vibration it is

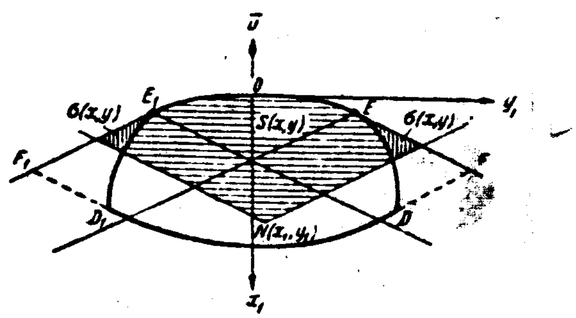

Figure 1

necessary to transform the integral equation

$$\int_0^x \int_{\varphi(\xi)}^y \frac{\Theta(\xi,\eta)\cos\{\lambda\sqrt{(x-\xi)(y-\eta)}\}}{\sqrt{(x-\xi)(y-\eta)}}\,d\eta\,d\xi = -\iint_{S(x,y)} \frac{A(\xi,\eta)\cos\{\lambda\sqrt{(x-\xi)(y-\eta)}\}}{\sqrt{(x-\xi)(y-\eta)}}\,d\eta\,d\xi \tag{1}$$

relative to function $\Theta(x, y)$.

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*Numbers given in the margin indicate the pagination in the original foreign text.

We seek the solution to (1) in the form

$$\Theta(x, y) = \sum_{n=0}^{\infty} \Theta_{2n}(x, y)\,\lambda^{2n} \quad \left(\lambda = \frac{\omega a}{u^2 - a^2}\right). \tag{2}$$

In both parts of the equation we add the cosine in the form of a line. Integrating the lines under the double integral sign, termwise, we reduce (1) to the form

$$\sum_{n=0}^{\infty} \lambda^{2n} \sum_{k=0}^{n} \frac{(-1)^{n-k}}{(2(n-k))!} \int_0^x \int_{\psi(\xi)}^y \Theta_{2k}(\xi, \eta)(x-\xi)^{n-k-1/2}(y-\eta)^{n-k-1/2}\, d\eta\, d\xi =$$
$$= \sum_{n=0}^{\infty} \lambda^{2n} \frac{(-1)^{n+1}}{2n!} \iint_{s(x,y)} A(\xi, \eta)(x-\xi)^{n-1/2}(y-\eta)^{n-1/2}\, d\eta\, d\xi. \tag{3}$$

Equating in (3) the coefficients for single layers λ, we obtain the equations satisfied by $\Theta_{2n}(x, y)$: /762

$$\int_0^x \int_{\psi(\xi)}^y \frac{\Theta_{2n}(\xi, \eta)}{\sqrt{(x-\xi)(y-\eta)}}\, d\eta\, d\xi = F_n(x, y) \quad (n = 0, 1, 2, \ldots), \tag{4}$$

where

$$F_n(x, y) = f_n(x, y) + \sum_{k=0}^{n-1} f_n^{(k)}(x, y), \tag{5}$$

in which

$$f_n(x, y) = \frac{(-1)^{n+1}}{2n!} \iint_{s(x,y)} A(\xi, \eta)(x-\xi)^{n-1/2}(y-\eta)^{n-1/2}\, d\eta\, d\xi,$$

$$f_n^{(k)}(x, y) = \frac{(-1)^{n-k+1}}{(2(n-k))!} \int_0^x \int_{\psi(\xi)}^y \Theta_{2k}(\xi, \eta)(x-\xi)^{n-k-1/2}(y-\eta)^{n-k-1/2}\, d\eta\, d\xi, \tag{6}$$

function $f_n^{(k)}$ determined for $k \geqslant 0$ and $n > 0$.

For n = 0, equation (4) takes the form

$$\int_0^x \int_{\psi(\xi)}^y \frac{\Theta_0(\xi, \eta)}{\sqrt{(x-\xi)(y-\eta)}} d\eta\, d\xi = f_0(x, y). \tag{7}$$

The solution of this equation is given by formula (7) in note 1.

The function $\Theta_0(x, y)$ corresponds with the values $\partial\varphi/\partial z$ in the case of steady wing motion (for $\lambda = 0$).

The equations in the form (4) for various Θ_{2n} differ from each other only in the form of function $F_n(x, y)$.

If we find the coefficients Θ_{2k} for k = 0, 1, 2, ..., n - 1, then $F_n(x, y)$ is the known function in the equation satisfied by $\Theta_{2n}(x, y)$.

We note that for any n, the function $F_n(0, y) = 0$, the solution of (4) is obtained in the same form as that of (7), if in the solution of the last, instead of the function $f_0(x, y) = f(x, y)$ we place the function $F_n(x, y)$.

Then

$$\Theta_{2n}(x, y) = \frac{1}{\pi^2} \frac{1}{\sqrt{y-\psi(x)}} \int_0^x \frac{\partial}{\partial\xi} \left\{ f_n(\xi, \psi(x)) + \sum_{k=0}^{n-1} f_n^{(k)}(\xi, \psi(x)) \right\} \frac{d\xi}{\sqrt{x-\xi}}$$
$$+ \frac{1}{\pi^2} \int_0^x \int_{\psi(x)}^y \frac{\partial^2}{\partial\xi\partial\eta} \left\{ f_n(\xi, \eta) + \sum_{k=0}^{n-1} f_n^{(k)}(\xi, \eta) \right\} \frac{d\eta\, d\xi}{\sqrt{(x-\xi)(y-\eta)}}. \tag{8}$$

Thus, the solution of (1) is presented in the form of an absolutely convergent line (2) for any values of parameter λ.

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REFERENCE

1. Krasil'shchikova, Ye. A. DAN, Vol. 58, No. 4, 1947.